Measurements Of Humidity in the Atmosphere: Validation Experiments (MOHAVE, MOHAVE-2)

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MOTIVATION

1. Water Vapor (WV) in UT/LS plays major radiative role
2. WV in UT/LS variability and trends not yet well understood
3. Accurate WV measurements in the UT/LS remains very difficult
4. Stable and reliable groundbased measurements needed to validate space-borne instruments (e.g., onboard Aura)

➔ The Network for the Detection of Atmospheric Composition Change (NDACC) now includes WV Raman lidar among its suite of long-term monitoring instruments

The MOHAVE campaign (October 2006) was designed to assess the current (and future) measuring capabilities of the WV Raman lidars

MOHAVE involved 5 lidars, 50+ PTU sondes, 10 CFH sondes, 2 GPS, 1 microwave, and more…

CAMPAIGN OPERATION

Site: Table Mountain, CA Alt. 2285 m Lat./Long. 34.4ºN, 117ºW

10 + 4 consecutive clear nights (14 total, October 14-28, 2006)

TMF WV lidar (Leblanc/McDermid, JPL)	96 hours
AT mobile lidar (McGee, NASA-GSFC)	113 hours
SRL mobile lidar (Whiteman, NASA-GSFC)	44 hours
CFH + ozonesonde (Vömel, CIRES/Univ. Col.)	10 launches
RS92 PTU radiosoundings (Vaisala)	37 launches (49 sondes)

Also on-site during the campaign:

WV Microwave (NRL)

Two GPS receivers (JPL, GSFC)

Tropospheric ozone lidar (JPL)

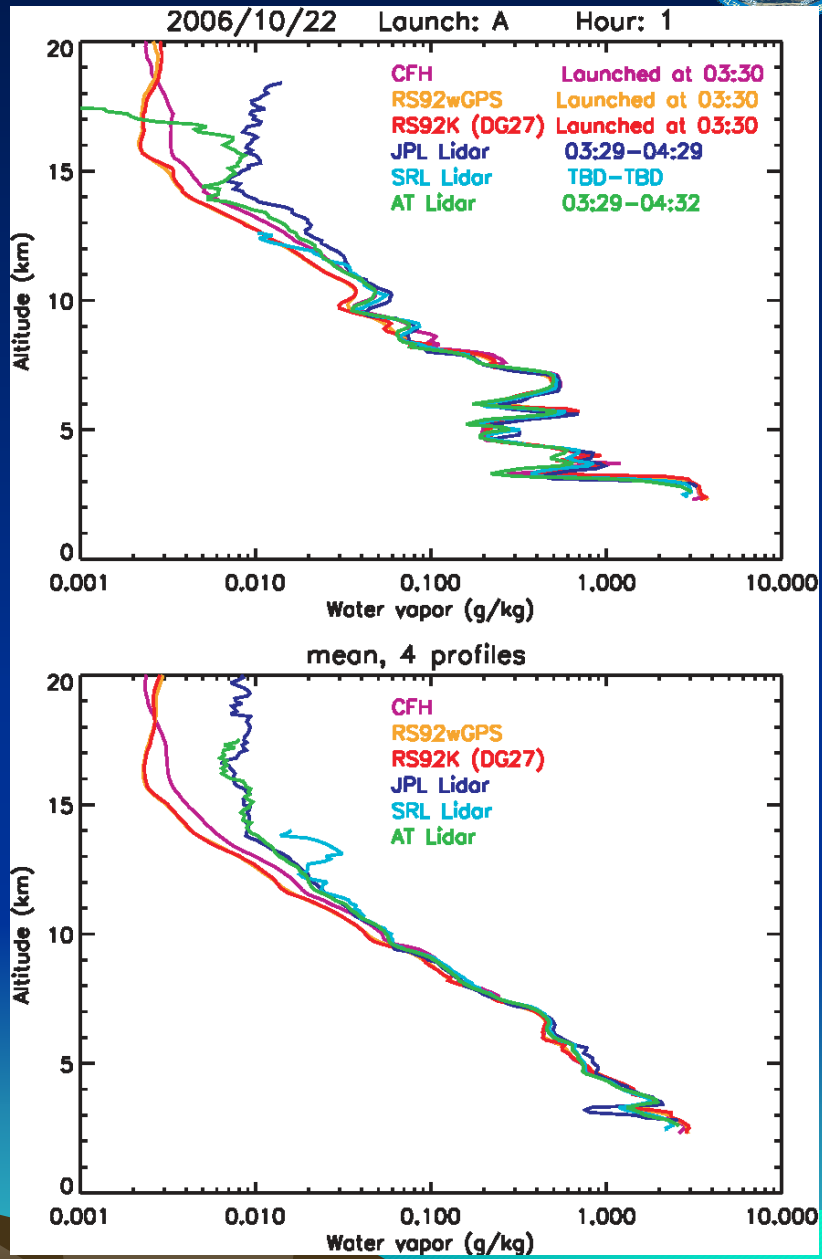
Stratospheric ozone/temp lidar (JPL)

Example of simultaneous measurements

Top:
October 22, 1-hour profiles
all instruments

Bottom:
Mean of the four 1-h profiles
obtained simultaneously
by all the instruments

➔ Wet bias of the lidars w.r.t. CFH above 12 km



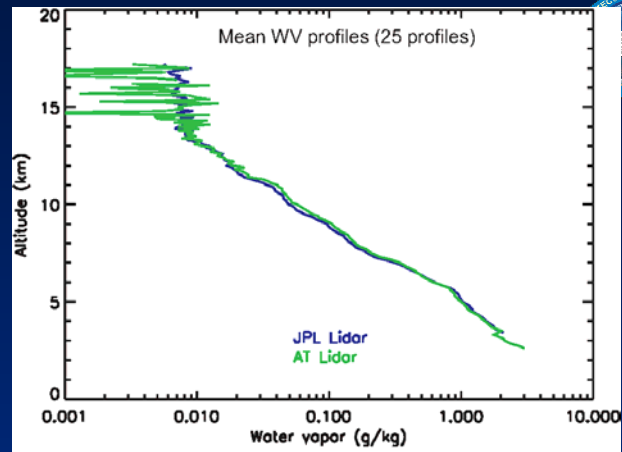
JPL Lidar – AT Lidar comparison

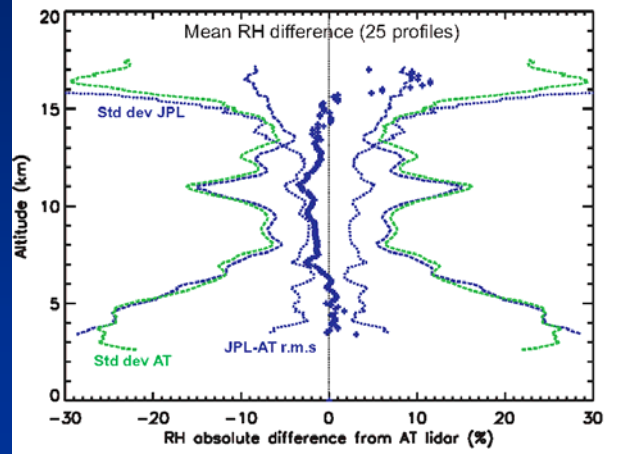
Top:
Mean of the 25 1-hour profiles
Simultaneously measured

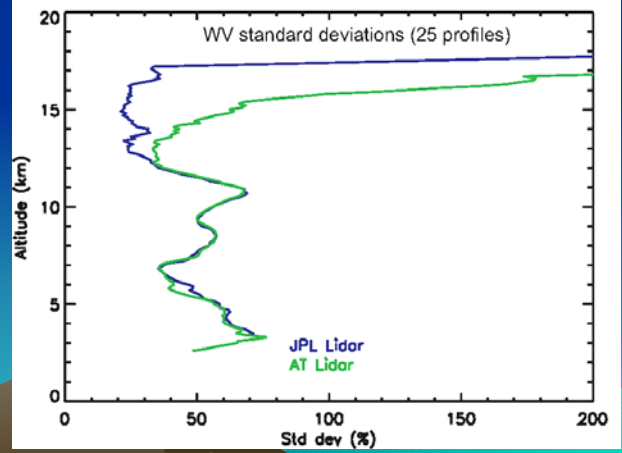
Middle:
Mean difference, r.m.s. and standard dev.

Bottom:
Standard deviations

➔ Both lidars agree very well;
Noise slightly higher for AT lidar



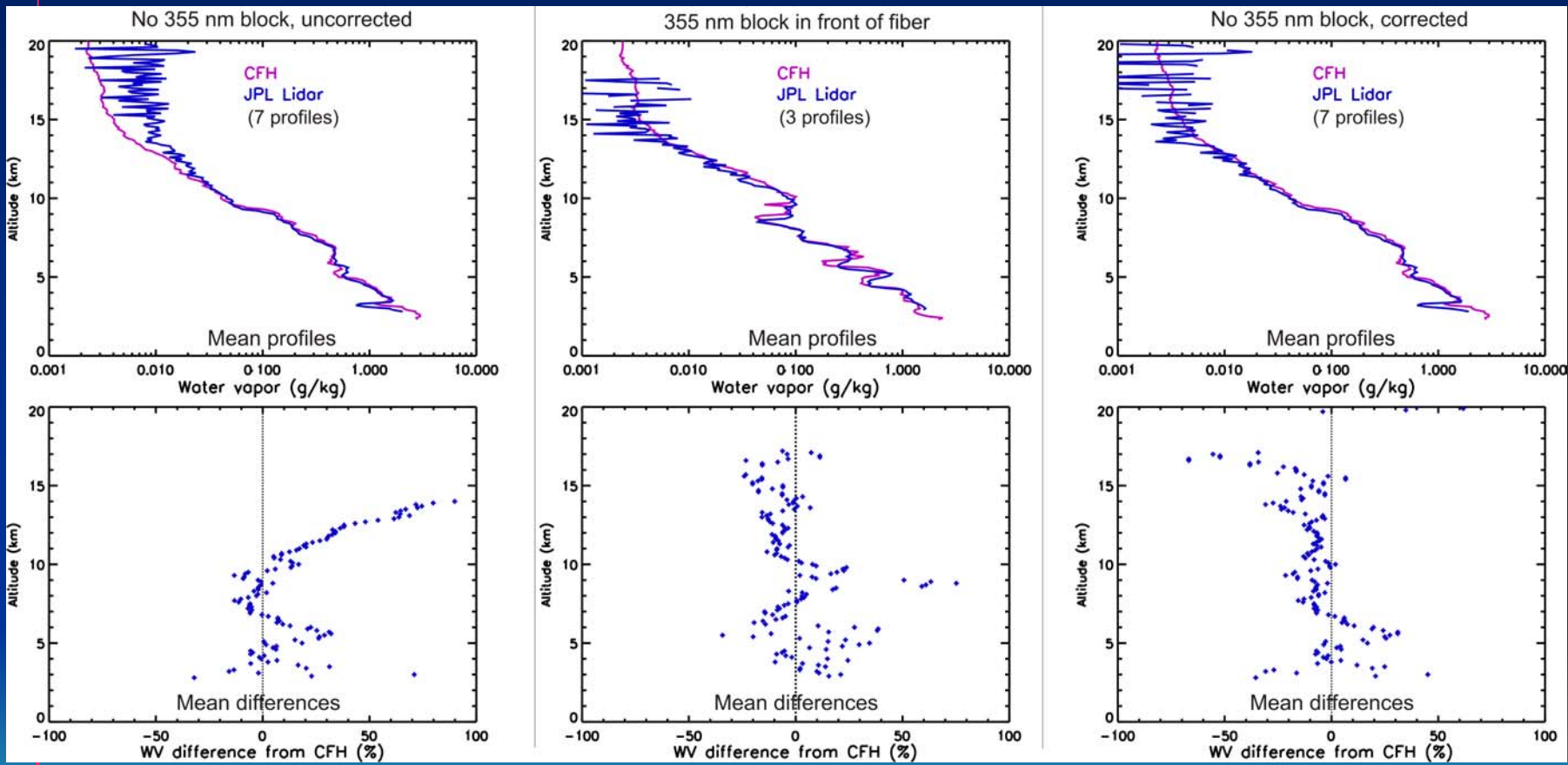




Comparison JPL Lidar - CFH

Left:
Mean 7 profiles with no 355 nm block
➔ Lidar wet bias

Middle:
Mean 3 profiles with a 355 nm block
➔No more bias!



➔ Fluorescence in lidar receiver optic fiber removed
= Major finding

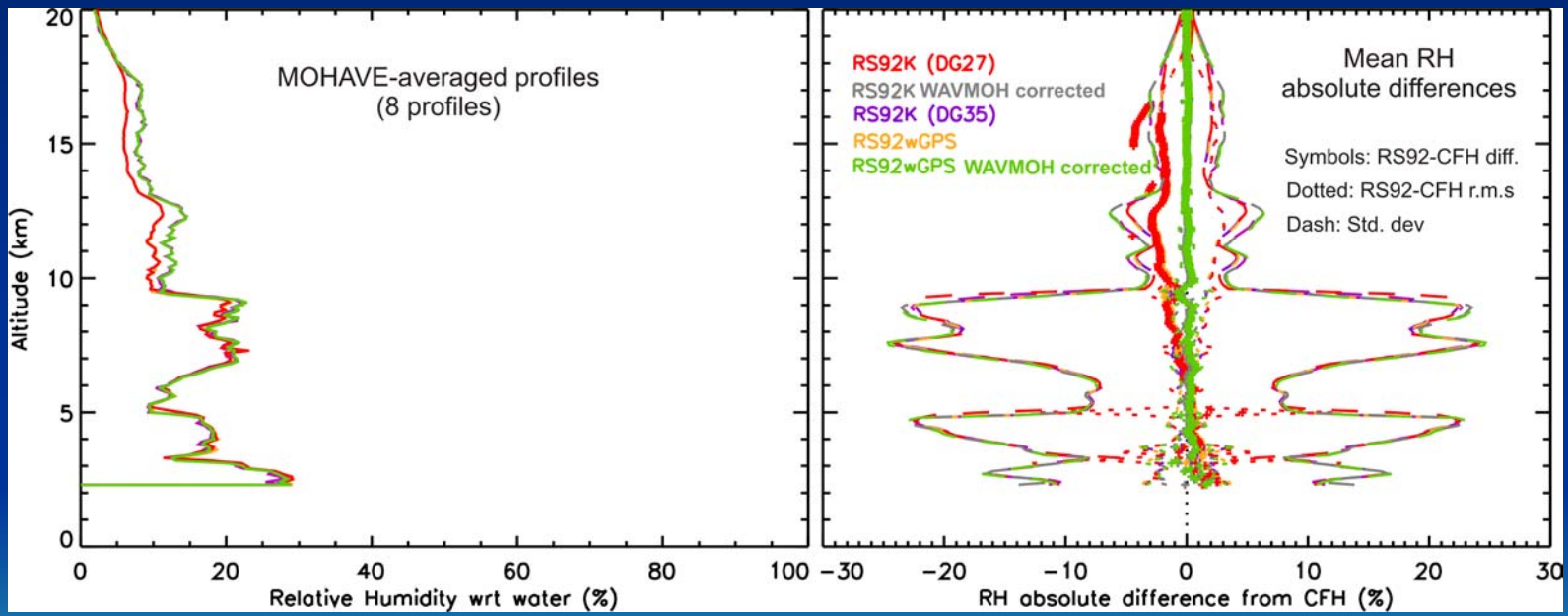
Comparisons Vaisala RS92 - CFH

Left: Profiles

Purple = CFH (ref)
Red = RS92K by JPL
Orange = RS92 w/ GPS by GSFC
Grey = As red, but with Milo* correc.
Green = As orange but with Milo correc.

Right: Differences

Red = RS92K by JPL
Orange = RS92 w/ GPS by GSFC
Grey = As red, but with Milo correc.
Green = As orange but with Milo correc.
Purple = As red but processed w/ DG35



➔ *Miloshevic's empirical correction (NCAR) seems to work well

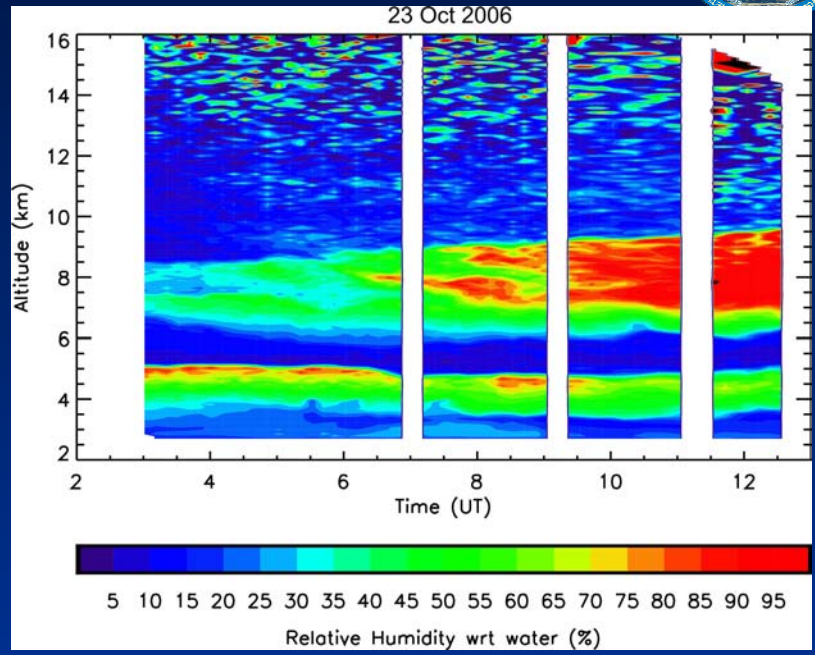
Lidar calibration and water vapor variability

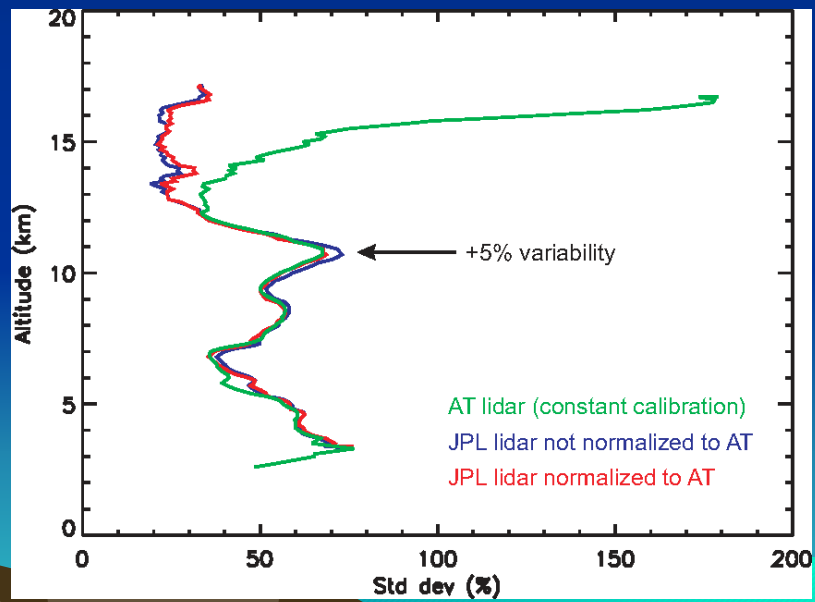
Top:
Shows high WV short-term variability

Bottom:
Shows WV variability for different calibration configurations

Green = AT lidar calibrated w/ constant
Red = JPL lidar calibrated to AT lidar
Blue = JPL lidar calibrated to RS92K

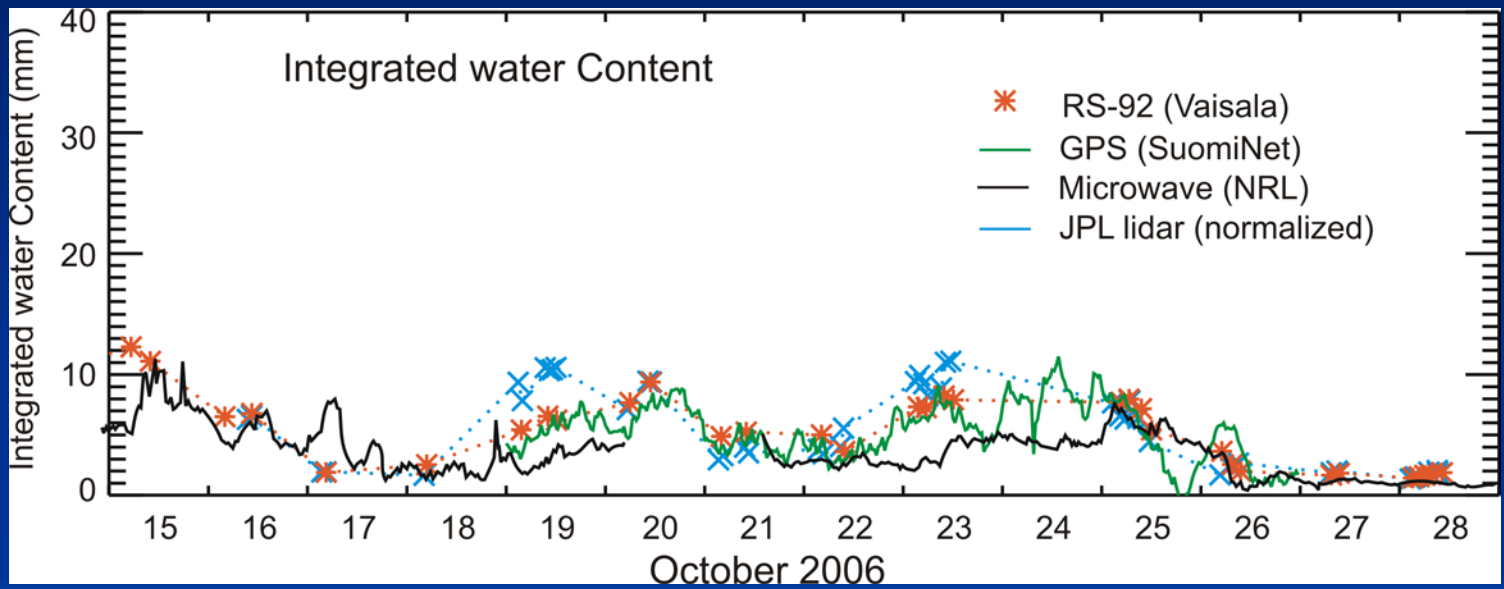
➔ To be considered carefully for long-term applicability





WV lidar calibration: Search for alternate methods

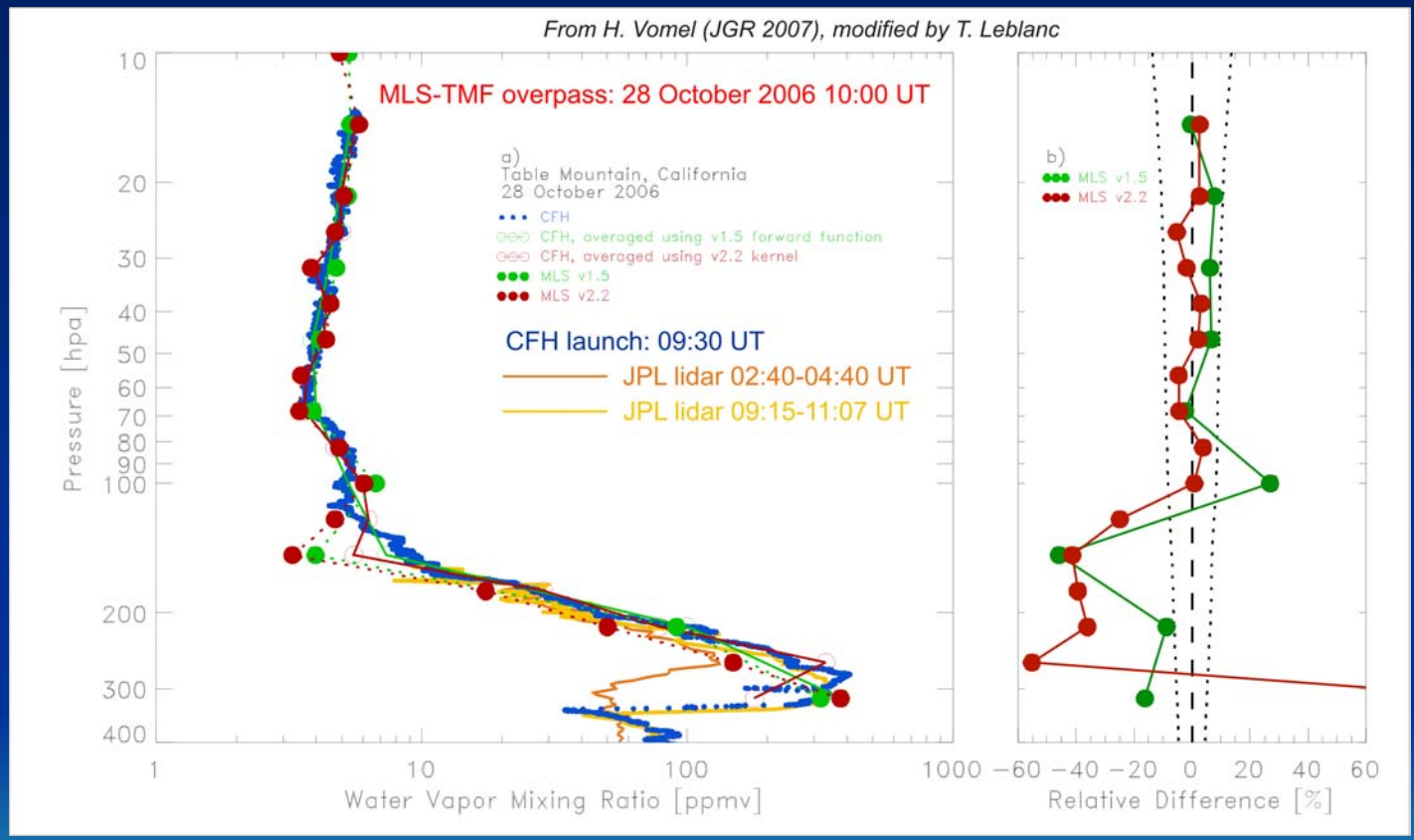
Below:
Comparisons of integrated WV measurements looks promising



➔ **This alternate (cross-) calibration method will be considered in the future**

What about Aura? ➔ MOH-AVE

Below:
October 28 comparison CFH and JPL lidar with Aura-MLS



Good agreement despite large variability at 250-300 hPa
➔ Demonstrates the critical impact of high variability and the resulting difficulty to validate WV measurements

CONCLUSIONS

1. MOHAVE was a successful campaign
2. Fluorescence was found to be inherent to all three participating lidars
3. Once fluorescence was removed, agreement with CFH was extremely good up to 18 km altitude

➔ Water vapor Raman lidar found to be a promising instrument for the long-term monitoring of water vapor in the UT/LS,

BUT…

Additional laser power and improved efficiency of the lidar receiver are required to achieve trend detection capability

➔ MOHAVE-2 starting October 4, 2007 (this Thursday)

Lidars reconfigured to remove 2006 fluorescence